portunity to acquaint himself with other institutions and their staffs, such advantages as some of us on a larger scale have enjoyed through membership in the Interurban Clinical Clubs. From the local programs could be selected the best material for presentation before the national society. From the local society could be selected those most fit for full membership in this organization. Thus, without necessarily increasing the number of meetings, through the organization of subsidiary, local societies, the spirit of investigation could be better cultivated among those whose need is greatest. Since the aims are identical, the advantages accruing to the members of the local organization are obvious, but whether their relation to us should be official or unofficial is for us to decide.

Dr. Meltzer, the founder of this society and the prototype of the clinical investigator, recognized very clearly the need of encouraging younger men in their investigative aspirations. We could not do greater honor to his memory than to follow his example and create local centers fostering clinical investigation.

LEONARD G. ROWNTREE

THE MAYO CLINIC

OBSERVATIONS OF THE AURORA AT THE LOWELL OBSERVATORY MAY 14, 1921

THE very brilliant auroral display which appeared on May 14 exhibited frequently the phenomenon of streamers diverging from a definite point in the heavens, and it was often possible to locate this radiant, with reference to the stars, with considerable accuracy. The resulting positions, with the times of observation, are as follows:

Mountain Time	Hour Angle	Declination
$8^h\ 54^m$	$+47^m$	$+4°.5$
8 56	+39	+3 .6
9 00	+39	+4 .4
9 01	+44	+4 .4
9 04	+30	+3 .7
9 06	+34	+3 .1
9 13	+39	+3 .7
9 16	+38	+2 .6
9 19	+40	+3 .0
9 20	+37	+2 .7
9 24	+31	+2 .2
.. ..	....	.....
10 49	+21	+2 .3
10 55	+31	+2 .8
11 02	+26	+3 .8

Jupiter, Saturn and β Virginis served as comparison stars for the earlier observations and ζ Virginis for the last three. The means of the first eleven estimates and of the last three, give:

Mountain Time	Hour Angle	Declination	Altitude	Azimuth
$9^h\ 08^m$	$+38^m$	$+3°.4$	$57°.2$	S $17°.4$ W.
10 55	+26	+3 .0	57 .4	S 12 .1 W.

The average deviation of a single observation from the mean is $\pm 0°.7$ in declination and $\pm 3^m.5$ in hour angle, so that the difference between the two positions appears to be real.

The mean of the two, giving the first double weight, places the radiant in altitude $57°.3$, azimuth S $15°.6$ W. The magnetic dip at Flagstaff is 62° and the variation 15° E. so that the radiant was very nearly on the magnetic meridian but about 5° south of the "magnetic zenith."

The aurora was not only very bright, in spite of the light of the half moon, but extended surprisingly far south. About 9 P.M. several bright patches were seen low in the south, and at 11 the whole southern sky was full of streamers and patches of light.

At 10:57 a remarkable group of short curved streamers appeared surrounding the radiant. These were but a few degrees in length, but very bright, and a distinct motion of the luminosity along the streamers was visible,—outward in all directions from the radiant, and with a curvature in a counter-clockwise direction. The motion was rapid, covering the length of the visible streamers in less than a second, and the impression was strong that what was seen was the actual motion of the particles which enter the atmosphere and cause the luminescence.

HENRY NORRIS RUSSELL

May 16, 1921

During the last twenty years I have known of bright auroral displays being observed in Arizona on only a few occasions. One of these was on June 15, 1915, another one on March 22, 1920, and a third on the 14th of the present May. The first and the third of these were observed at the Lowell Observatory, but not the second one as it came during unfavorable observing weather at Flagstaff. Of the two I observed, that of May 14 was much the more brilliant and wonderful (and this doubtless was also a finer display than that of March 22, 1920). It was recognized about 8:30 o'clock, and rapidly increased in brightness, soon displaying streamers and bright and dark cloud masses with the curtain or drapery features. These continued bright for some time and then in more or less subdued intensity during about an hour when the northern sky began again to show the arch and drapery effects rising and it was soon evident that another outburst was developing. This one then also progressed rapidly and at its height near eleven o'clock it was even more remarkable than the first.

The rays (for convergence of these see observations of Dr. Russell and Mr. Lampland given herewith) and the cloud forms were present in all parts of the sky at eleven o'clock. Some of these in the southern sky attracted my attention particularly by undergoing striking fluctuations in brightness. These would be bright for a few minutes, would then fade nearly or quite to invisibility, brighten again and fade, repeatedly, in the same position. There were a few small ordinary vapor clouds scattered low in the east and northeast and one or two in the southwest, which as reference objects brought out clearly the very different and fleeting behavior of the auroral clouds, both the luminous and the dark, which impressed me as being the remnants of the dismembered arch and draperies that spread over the whole sky. The spreading of the auroral canopy southward over the sky was most striking as it swung forward through the east and the west. The color displayed was most noticeable in the northwest where a red tone usually prevailed and was at times quite strong. A less intense red tint was sometimes very evident in the northeast. I did not see the blue tones sometimes reported for northern auroral displays. The most of the light was of the intermediate colors, silver with more or less greenish yellow, the silvery tone being noticeable for the higher streamers and the green and yellow tones increasing somewhat with the zenith distance, and particularly was the northern sky generally yellow with some green and less often some red tones.

My efforts were directed toward getting spectrographic observations of the aurora. Unfortunately no properly adjusted spectrograph was in readiness, but owing to the length of the display two slit spectrographs could be set up and three useful spectrograms secured. Two of these were with a single prism and a three and a quarter inch focus camera, and the third with a very dense prism and a 15 inch focus camera. The first of the small scale spectra on an isochromatic plate, is the stronger and shows about fifteen lines and band heads between λ 3800 and the chief aurora line at λ 5578.0. Those near λ 3914 and λ 4276 were especially strong and appeared to be the less refrangible edges of flutings (band heads)—this is probably also true of the radiation near λ 4650. The other small scale spectrum, on Ilford Panchromatic plate, shows the stronger of these lines, including the line λ 5578 and a line in the red whose wave-length according to my preliminary measures is near λ 6320.

The negative made with the higher dispersion instrument, on Ilford red plate, records only faintly the chief aurora line, measures of which give the wave-length as 5577.8. This is in satisfactory agreement with the value 5578.05, which I found some years ago for this line from higher dispersion plates exposed to the permanent auroral light of the sky. This observation is of interest in that it leaves no further doubt that the wave-length is the same, within the errors of observation, whether the auroral light is that permanently scattered over the sky or is that of a violent storm display. The red line λ 6320 had been previously observed visually but this is I be-

lieve the first time it has been photographed and the negative should furnish much the more accurate determination of its wave-length.

V. M. SLIPHER

LOWELL OBSERVATORY,
FLAGSTAFF, ARIZONA,
May 20, 1921

THE magnificent auroral display seen at the Lowell Observatory on the evening and night of May 14 was of much interest to observers in a latitude so far south on account of the great brilliancy and diversity of types of many of the formations and their widespread distribution over the sky. The auroral light was first recognized about 8:25, or a little earlier, before twilight had disappeared. The lower sky was then very brilliant in the north and particularly in the northeast, and the characteristic greenish auroral color was predominant but over parts of the active areas a suffused ruddy glow was conspicuous, especially in the northeast. Almost immediately streamers made their appearance in the north and northeast. Ten or fifteen minutes later the display developed into great activity. Long brilliant streamers were reaching up towards the zenith and beyond, and at the same time occurred in various parts of the sky, but especially in the east and west, brilliant patches, and masses of light suggesting unevenly illuminated cloud forms as when cumulus masses are lighted on one side with the great bulk of the cloud thrown into relief by the parts that are more feebly illuminated or in the shadow. One was inclined at first to attribute these massive forms, the darker parts barely perceptible against the background of the sky, as being partially due to atmospheric clouds. But their auroral origin soon became evident. The entire formation vanished when the auroral activity in that region ceased, and also, with some attention, it was possible to distinguish the few inconspicuous ordinary atmospheric clouds present. Several of the brilliant patches persisted in nearly the same position for some time, fading out and brightening up again repeatedly.

The greatest activity of the second outburst occurred between the hours of 10 and 11. Auroral formations were at that time visible in practically all parts of the sky, exhibiting simultaneously streamers, luminous masses, and bright patches, and all undergoing incessant change. Streamers from every direction were playing across the heavens, the great beams of light gradually becoming narrower on approaching the region of convergence.

The activity in the region near the convergent was at times quite remarkable. The transformations were complex and rapid, the luminous detail flaring up and fading out in almost the twinkling of an eye in some instances. About 10:46 occurred a very striking display in this area when detail formed and dissolved at an extremely rapid rate, structure appearing in momentary flashes and at one time suggesting the fragments of a partially formed crown.

The term "convergent" will be used in connection with the phenomena of the streamers, as I had frequently the impression that the streamers from different directions *did not radiate* from the region of their concurrence but in many cases took a perceptible interval in rising from the lower parts of the sky to the point in question, gradually approaching it in a series of intermittent or pulsating advances. Doubtless the apparent configuration is a matter of perspective as in the case of meteor paths. The streamers descending along the lines of force of the earth's magnetic field are for any locality nearly parallel and the vanishing point—the point where the streamers appear to meet—would be the highest altitude at which the streamers become visible. Strictly speaking, it might be more definite to use the term radiant as understood for meteors.

The writer made several estimates of the convergent of the streamers but he missed many opportunities for additional estimates as well as for observing and recording numerous other phenomena in attempting to photograph the streamers in the region of their concurrence. At this point, or small area, the streamers were much of the time comparatively faint

and never long at rest, and when momentarily a favorable formation developed the intensity fell off too rapidly to give suitable photographs for accurate determination of the convergent. At times the convergent could be readily determined when streamers from many different directions were nearly or actually concurrent and the position of this point could be located with reference to comparison stars. My own observations were as follows:

M. S. T.		H. A.		Dec.	Azimuth	Altitude
h.	m.	h.	m.	°	°	°
9	10	0	36	3.6	16.8	57.3
9	14	0	36	2.8	16.6	56.5
9	16	0	36	2.8	16.5	56.5
9	19	0	45	3.0	20.3	56.2
9	22	0	38	2.2	17.2	55.8
		0				
10	50	0	22	—0.2	9.4	54.2
10	52	0	21	+3.7	10.0	58.1
11	25	0	30	+1.9	13.5	56.0

These observations, and also Dr. Russell's, show that generally the point of convergence was near the magnetic meridian but between 5° and 6° south of the "magnetic zenith" (coordinates of the magnetic zenith for Flagstaff are: azimuth S. 15° W.; altitude 62°). If the auroral streamers follow the lines of force of the earth's magnetic field the higher parts of the streamers might be expected to show a deflection in the direction indicated but no calculations have been made to see if the magnitude of the apparent displacement might be of the order observed. What the effect of parallax may be is also a point not to be overlooked. There can be little doubt but that the point of convergence was subject to greater actual variation in azimuth than altitude. In the magnetic disturbances that accompany auroras it is possible that changes in the earth's magnetic field might be perceptible in the course of the auroral streamers.

At 10:44 a series of parallel streamers, coming into view almost directly overhead and extending east and west, were seen drifting very rapidly towards the north, with undulating and flickering motions flowing lengthwise through them. They were visible for only a moment, the detail dissolving a short distance north of the zenith, and one had the impression that the phenomena taking place were comparatively near.

Streamers of both narrow and broad (at times somewhat diffuse) types were present. As a rule a greenish tint was most prominent in both the streamers and the extensive luminous areas but a pinkish or ruddy color was also much in evidence. At various times pinkish or pale red streamers were seen, generally in the northeast or northwest. A broad pinkish streamer in the northwest appeared to be rather quiescent and remained visible much longer than any of the other streamers during the display. It was 3° or more in width, extending perpendicularly upward from the horizon about thirty degrees. About 12:35 a superb display of both pinkish and green streamers was visible for a few minutes in the northeast, extending up about 45° from the horizon, considerably inclined southward. Throughout the display streamers of greatly varying intensity playing upward from the northern horizon were visible but these were not as conspicuous as might have been expected in view of the brightness and activity of the auroral light in other parts of the sky. Occasionally these streamers were subject to marked flickering, and some movement—a slow lateral drift. Now and then dark lanes occurred between the streamers, and in one instance a very conspicuous dark rift had a leisurely motion eastward.

From the time the auroral light was first made out in the waning twilight it was strong, with greatly increased intensity during the intervals of the outbursts mentioned, until after 1 o'clock when it rapidly subsided into a feeble glow along the northern horizon. It was reported by someone stationed at a sheep camp north of the San Francisco Peaks that another outburst of streamers developed later in the night.

The auroral light must have been of great intensity as the display was a magnificent spectacle even when dimmed with the light of the moon near the first quarter.

On the day following the display two spots

of considerable size were seen on the solar surface not far from the center of the disk.

C. O. LAMPLAND

LOWELL OBSERVATORY,
FLAGSTAFF, ARIZONA

SCIENTIFIC EVENTS

THE PRODUCTION OF FIXED NITROGEN

THE final report of the Nitrogen Products Committee of the British Ministry of Munitions, issued early in 1920, has been supplemented by a series of statistical tables relating to nitrogen fixation, now publlished by the Stationery Office, covering the latter part of the war and the period that has elapsed since its termination. This additional information has been compiled by Dr. J. A. Harker, formerly director of the Nitrogen Research Laboratory, for the Department of Scientific and Industrial Research.

Among other things, the statistics deal with the world's resources in nitrogen products, the Chile nitrate industry, the production of nitric acid and sulphate of ammonia, the synthetic ammonia process during the war, and the cyanamide industry. It is estimated that the world's capacity for the production of fixed nitrogen amounted last year to 1,561,000 tons, of which about 57 per cent. was attributable to natural sources, such as Chile nitrate and the by-product industry, and the remainder to artificial fixation processes.

The London *Times,* from which we take this information, says:

> The most striking, and in some ways the most disquieting, feature of the statistical supplement to the Nitrogen Products Committee's report (mentioned in *The Times* of yesterday) is the great increase in the world production of fixed nitrogen, and of the fact that of the 50 plants in operation throughout the world, not one is established in this country and only two are to be found within the Empire. Canada has one arc process plant with a maximum capacity of 800 metric tons a year and a cyanamide process plant estimated to be capable of 12,000 tons. Thus, of the world's total estimated capacity for 1920 of 671,300 tons, the British Empire commands only 12,800 tons.
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> A fuller examination of the position reveals the conclusive predominance of Germany in this field. While Norway outdistances all rivals in the arc process, producing 30,000 tons out of a total of 38,300, Germany, taking the three processes together, produces nearly twice as much fixed nitrogen as the rest of the world. Of the 325,000 tons credited to the cyanamide process, Germany commands 120,000, while under the synthetic ammonia process she has a capacity of 300,000 tons, and the only rival is the United States, with the almost negligible figure of 8,000. Put in a sentence, Germany can produce by fixation processes 424,000 metric tons of nitrogen a year, and the rest of the world can produce only 237,000 tons, of which this country produces none.
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> Our one internal source of fixed nitrogen is therefore by-product works, and even there we produce only 100,000 tons against Germany's 150,000. As a net result our internal resources —that is, the resources on which we should have to rely if all colonial and foreign supplies were cut off—represent 2,240 tons of fixed nitrogen per million of population, while Germany's resources amount to 8,830 per million of her population. It is sometimes suggested that our inaction in this field may yet prove of advantage, since by waiting until experiment had demonstrated the best process, we might adopt it and then pick up our competitors. The history, however, of our loss of the synthetic dyestuff industry, which began in 1856 with Perkin's discovery of mauvine and still flourished for 20 years after, gives little support to this complacent theory.
>
> The plain truth is that while other countries, especially Germany, have carried their experimental work well into the productive and commercial stage, we are still engaged in constructing plants and debating the merits of the processes of German, French, and other chemists. The synthetic ammonia factory at Billingham, designed to manufacture about 60,000 tons of ammonia nitrate annually for war purposes, was begun by the Ministry of Munitions early in 1918, but at the time of the Armistice was only very little advanced. This is now being redesigned by Brunner, Mond and Co., to manufacture fertilizers, and a subsidiary company is at present concentrating upon designs for an initial plant to produce 25 tons of nitrogen per day or about 6,000 to 7,000 tons annually. Cumberland Coal Power and Chemicals, Limited, have purchased the British rights in the French process by Georges Claude, and the British Cyanides Company are continuing at Birmingham their large-scale experiments on fixa-